Photonuclear data and modern giant resonance physics

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The aim of this work is to try to attract the attention of the photonuclear data experts to recent results in giant resonance (GR) physics and to propose an idea for parametrization GR, which is especially necessary for astrophysics[1] and for unstable nuclei.

GR physics was developing very quickly in the 80-th and at the beginning of the 90-th ("GR physics renaissance"). The largest changes were probably just for the resonances which are of greatest interest for photonuclear data, namely, for the isoscalar E2, isovector M1 resonances and, relatively recently, for the low-lying E1 strength, the co-called pygmy dipole resonance (PDR). (See also the contribution to this conference by Kamerdzhiev, Kovalev and Litvinova).

Beginning from the known review of Bertrand [2], the experimental parametrizations and systematics of the GR data were based , as a rule , on the estimations by Landay and Eliashberg obtained within the infinite Fermi liquid theory, namely the resonance mean energy and width are proportional to $A^{-1/3}$ and $A^{-2/3}$, respectively. However, in the recommended libraries RIPL1 and RIPL2 the very large value 4 MeV of the M1 resonance width was recommended for all nuclei and for the isoscalar E2 resonance a linear A-dependence was used. The situation with the temperature dependence of the E1 strength has changed drastically as compared with the T^2 Fermi liquid dependence.

The large-scale QRPA calculations of E1 strength [3] for about 6000 nuclei have shown that, in order to explain the PDR properties, it necessary to go beyond the QRPA theory and,in authors' opinion, to add a contribution of more complex configurations with phonons.

Taking into account , in addition, the necessity of nuclear data for unstable nuclei [1] one can propose the FOLLOWING PROCEDURE FOR THE CALCULATIONS AND SUBSEQUENT PARAMETRIZATION OF PHOTONUCLEAR DATA. It is necessary to use a consistent microscopic theory [4] for non-magic nuclei[5] with universal interaction parameters which takes simultaniously into account all three known mechanisms of GR damping: the single-particle continuum (to describe properties of light and medium weight nuclei and dripline nuclei), the QRPA contribution and the phonon coupling, which explains one half of the GR width in stable nuclei [4]. After corresponding GR calculations for some selected nuclei it is necessary to parametrize the results as a function of N and Z in order to obtain the GR and PDR parameters suitable for other nuclei or several groups of nuclei. This parametrization should be suitable for unstable nuclei also or at least for some groups of them. In princple, it is desirable to develope a variant of the microscopic theory with all the above-mentioned GR formation mechanisms which would be completely selfconsistent. Such a theory is in progress now. The procedure proposed is a rather labour-intensive one and underdeveloped technologically but at present it is fully realistic.

I thank Profs. J.Speth, S.Qaim and V.Plujko for useful discussions.

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